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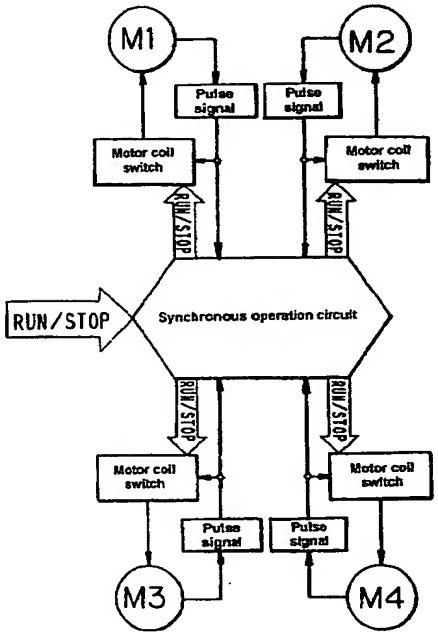
(54) A method for synchronizing several brushless motors in an elevating device

(57) In an elevating device arranging several elevating means at several positions, and employing compact motors to drive the several elevating means, to synchronize the several motors of the several elevating means accurately for smooth elevation.

Several brushless motors are used for driving the elevating means. A run signal or a stop signal is sent to each of the brushless motors M1 to M4 via a synchronous operation circuit. Whether a signal is a run signal or a stop signal is determined by comparing the pulse signals corresponding to the rotations of the brushless motors with each other, and when the pulse signal of one brushless motor is larger than the pulse signal of another brushless motor, the brushless motor having the larger pulse signal stops.

Fig. 1



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amples using motor rollers incorporating brushless motors as elevating means.

[0019] The elevating device shown in FIG. 3 comprises an elevating platform 3 and four motor rollers 1, 1 each equipped with an eccentric cam (arm) 2. When the motor rollers are turned 90°, the elevating platform is raised and lowered between the position indicated by the dotted line and the position indicated by the two-dot chain line. This elevating device is placed at an appropriate position along the conveyor line and used as a sorting device that discharges a conveyed item sideways by raising the elevating device 3. The elevating device 3 of this embodiment raises or lowers the elevating platform 3 by rotating the motor roller 1 at a certain angle.

[0020] The elevating device shown in FIG. 4 comprises an elevating platform 7, a frame 4 and two motor rollers 1, 1 each at the top of the left and right sides of the frame 4. A portion of each motor roller 1 is provided with a reel 6 on which a belt 5 is rolled. The ends of the belts 5, 5 are fastened to the four corner areas. The belts 5, 5 are reeled in or out at the same speed, thereby raising or lowering the elevating platform while maintaining the horizontal position. This elevating device can be embodied as an elevating device for a wheelchair.

[0021] FIG. 5 is a longitudinal section view of a motor roller 1, which functions as a reel 6. The motor roller 1 shown in FIG. 5 incorporates a brushless motor 9 inside its external tube 8, and the rotation of the rotor 9a of the brushless motor 9 is transmitted to the external tube 8 from an output part 9b via a reduction gear 10. The roller is attached to the frame 4 via fixed shafts 11. The external tube 8, which is linked to the rotor shaft 9a, rotates against the fixed shafts 11. Between the external tube 8 and the fixed shafts 11, bearings 12 are provided for smooth rotation. Inside the external tube 8, there is a fixed tube 6, which is provided with an electromagnetic brake 14 so as to be able to stop the rotation of the rotor shaft 9a physically. The motor roller 1 has guide rings 6a, 6a fastened on the external tube 8 so that a portion of the external tube 8 functions as the reel 6 for the belt 5.

[0022] The operation of the four brushless motors 9 (motor roller 1) will now be explained with reference to FIG. 1. As shown in FIG. 1, when a signal is input to the synchronous operation circuit, it is judged as a run signal or a stop signal by the synchronous operation circuit. Then the signal, which could be a run signal or a stop signal or a switch signal depending on the judgement of the synchronous operation circuit, is transmitted to M1 to M4, which are brushless motors 9, 9. The rotation conditions of the brushless motors are fed back to the synchronous operation circuit as pulse signals, and compared with each other for all four brushless motors. Then run signals are transmitted to these brushless motors in such a way that they are synchronized.

[0023] The control method for each brushless motor will now be explained with reference to FIG. 2. When there is no run signal from outside (when the external run signal is NO), the pulse signals for all of the brushless motors M1 to M4 are zero. In this case, stop signals are sent to all brushless motors, and the stopped condition is maintained. When there is a run signal (when the run signal is YES), M1 is compared with M2, which is adjacent to M1. If the number of pulses of M1 is larger, M1 stops. If the number is smaller, then M1 is compared with M4, another adjacent motor. If the number of pulses of M1 is larger, M1 stops. M1 runs (rotates) only when the number is smaller.

[0024] Next, M2 is compared with M1, which is adjacent to M2. If the number of pulses of M2 is larger, M2 stops. If the number is smaller, then M2 is compared with M3, another adjacent motor. If the number of pulses of M2 is larger, M2 stops. M2 runs (rotates) only when the number is smaller, In the same way, M3 is compared with M2 and M4 and stops or runs accordingly, and M4 is compared with M3 and M1 and stops or runs accordingly. At this time, if the numbers of the pulses are the same, the pulses are treated as run (rotate) signals. If a run signal is input from outside and a stop signal is sent to any of the brushless motors, said stop signal can be replaced with a deceleration signal. In this case, the movement of the elevating device becomes smoother.

[0025] As explained above, the brushless motors M1 to M4 form a comparative link in which the numbers of pulses are compared with each other among different pulse signals. In other words, the pulse signals of all brushless motors are directly or indirectly compared with each other. In this way, all brushless motors 9, 9 synchronize accurately. Depending on the type of elevating device, any number of brushless motors, i.e., elevating means, can be used.

Even in an application using a larger number of brushless motors, the same means can be used to control them. When using motor rollers incorporating brushless motors, the rpms of the motors can be detected as pulses at the motor driver that functions as the motor-roller driver. In this way, a synchronous operation circuit is easily accomplished without a special device for detecting pulses.

[0026] In a motor roller 1 incorporating a reduction gear, every time the external tube 8 of the motor roller turns, the brushless motor 9 turns several times, making it possible to detect several pulse signals. Because of this, as shown in FIG. 3, even in an elevating device in which the motor roller 1 rotates at a certain angle, the rpm of the motor roller can be accurately synchronized. When the motor roller 1 is used as a reel for reeling in a rope or a belt in an elevating device, an appropriate reduction ratio or diameter of the motor roller can be chosen taking into consideration the range and speed of elevation of the elevating device to achieve the elevating device that best suits the purpose.

1: motor roller
2: eccentric cam
3: elevating platform

Fig. 1

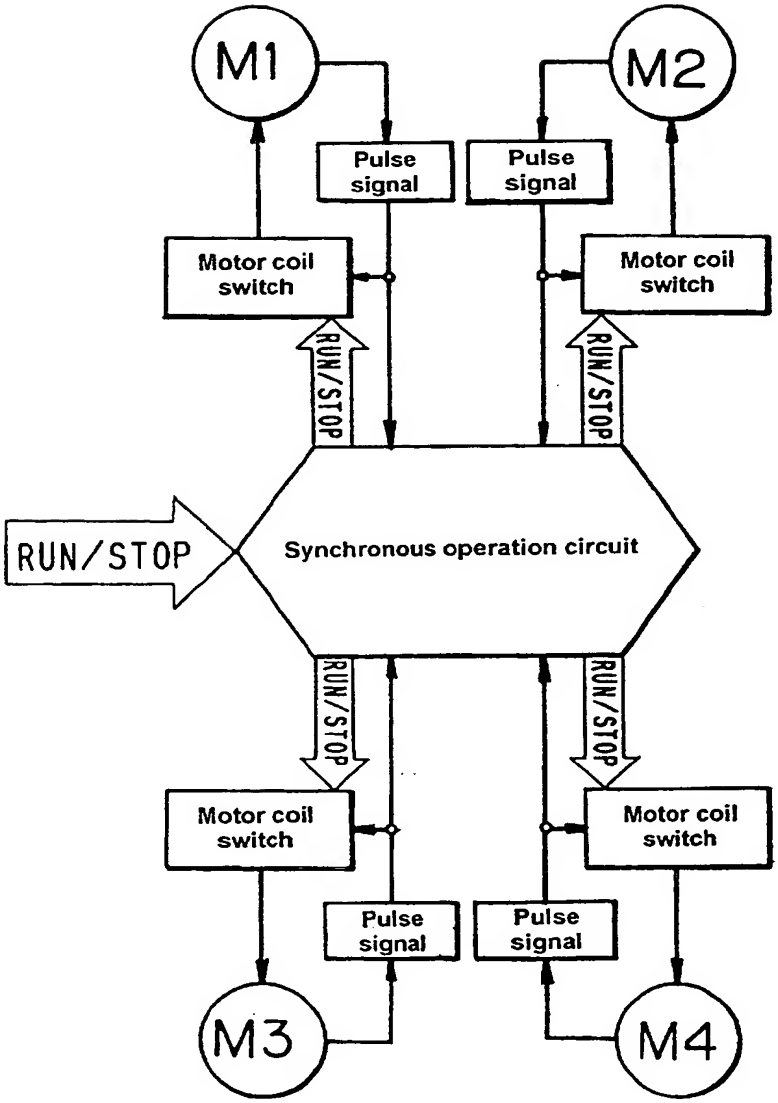

Fig. 3

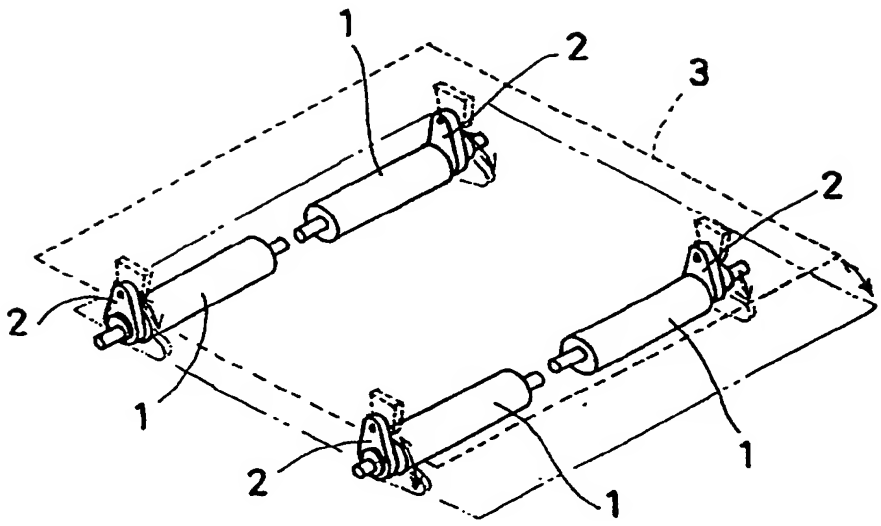

Fig. 4

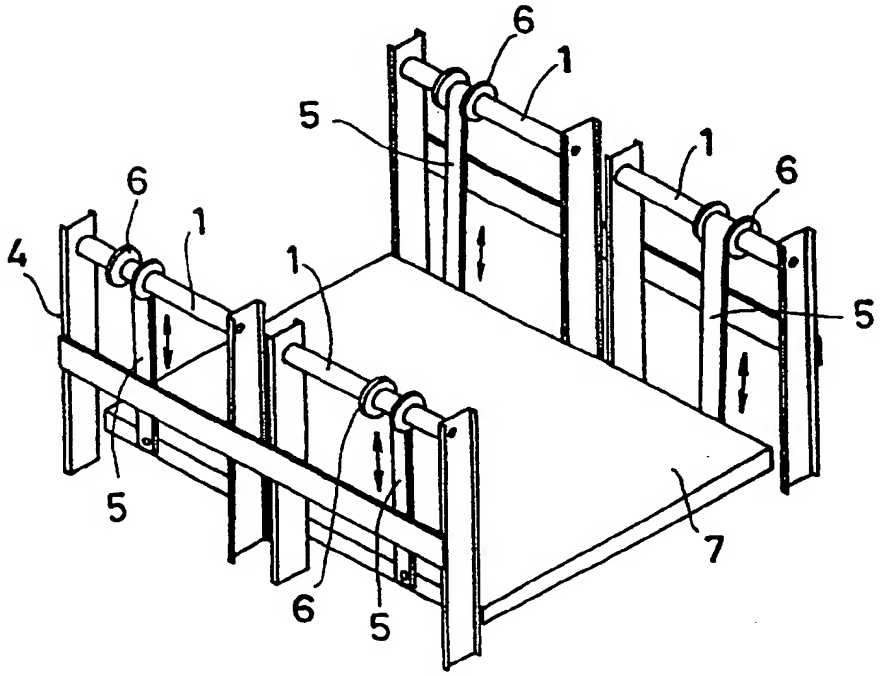

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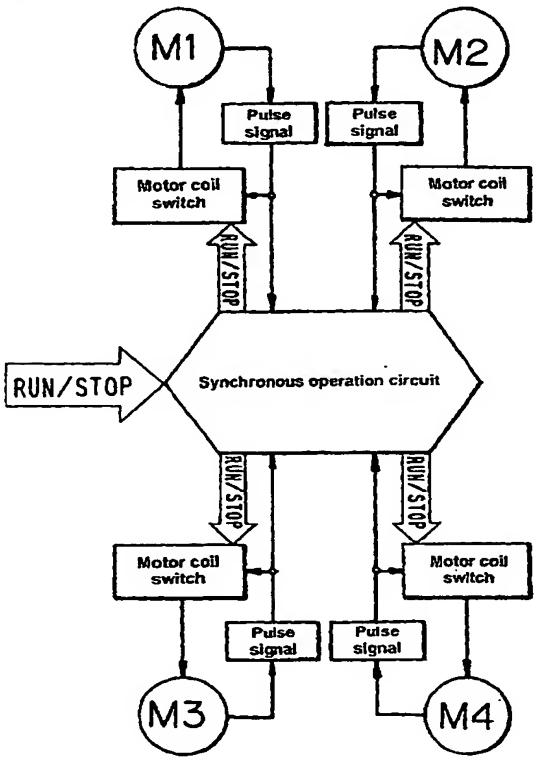
Fig. 1



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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 11 7764

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-10-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0526116 A	03-02-1993	JP 5030772 A	05-02-1993
		DE 69211919 D1	08-08-1996
		DE 69211919 T2	28-11-1996
		EP 0526116 A2	03-02-1993
		KR 9611212 B1	21-08-1996
		US 5323096 A	21-06-1994
US 3886417 A	27-05-1975	JP 983993 C	22-01-1980
		JP 49120353 A	18-11-1974
		JP 54014388 B	06-06-1979
		DE 2414559 A1	17-10-1974
GB 1148437 A	10-04-1969	CH 422962 A	31-10-1966
		AT 265441 B	10-10-1968
		BE 685198 A	16-01-1967
		DE 1280376 B	06-06-1974
		FI 43900 B	31-03-1971
		NO 118752 B	09-02-1970
		SE 312369 B	14-07-1969

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